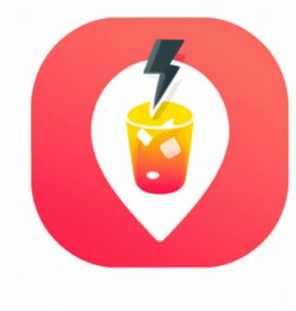
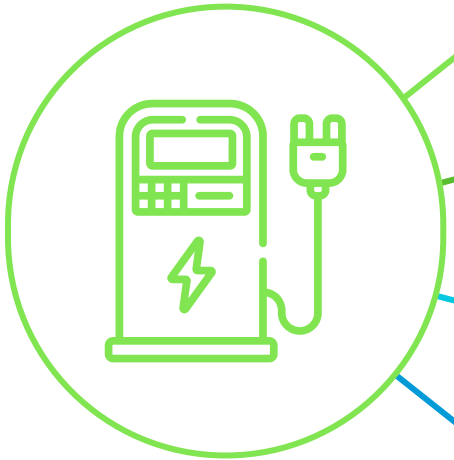


JuiceFinder

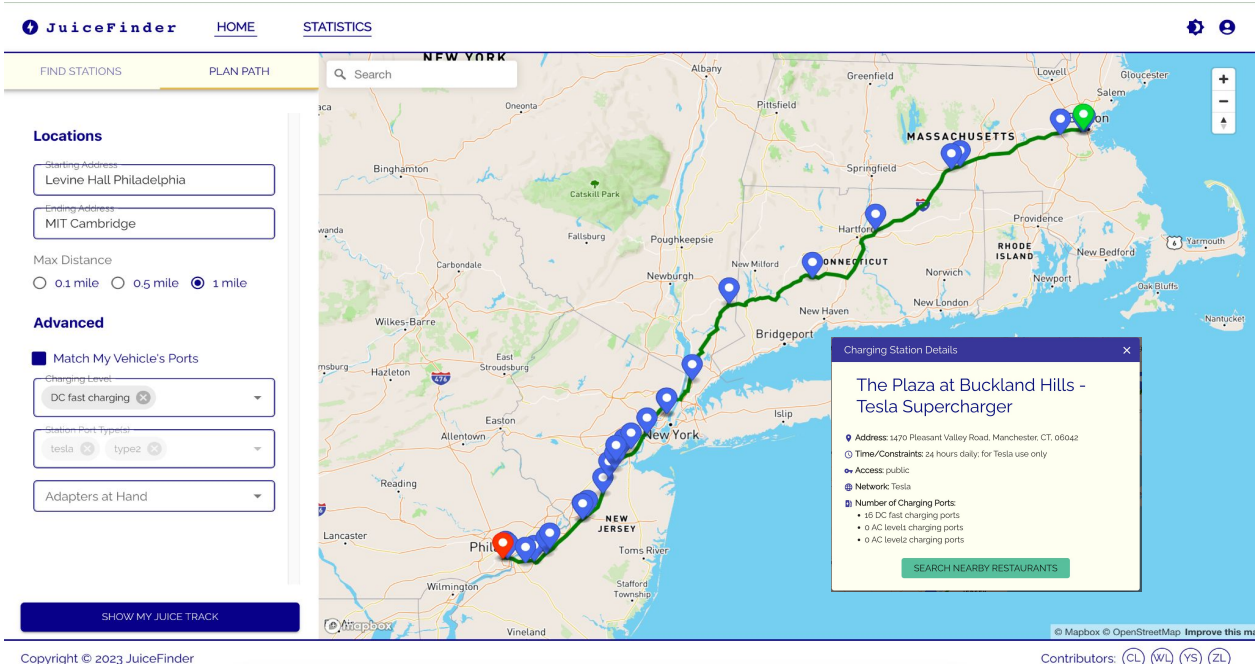
Chuan Li, Wei-Shen Lee, Zhiyang Lin, Yicheng Shen

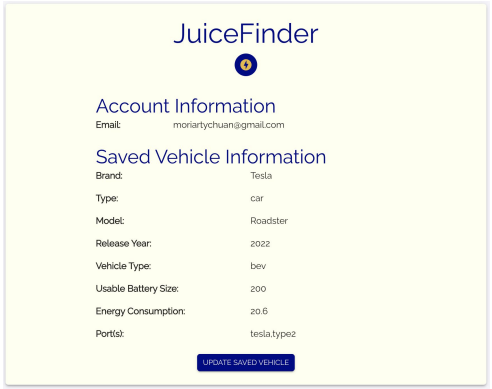
Basic Problems & Goals

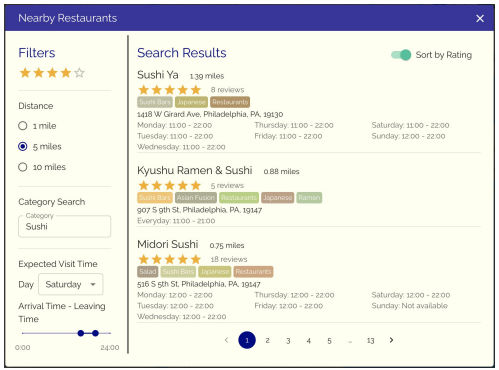


		Features
01	Where can I find nearby charging stations which are compatible with my EV?	Attribute-based/ Geolocation-based Station searching
02	Where can I charge my EV during the road trip? How to reduce my range anxiety?	Road trip planning
03	Are there any high-rating restaurants near the charging stations that are currently open?	Food searching
04	Does each state supply enough stations to meet rising EV's demand?	Resource allocating

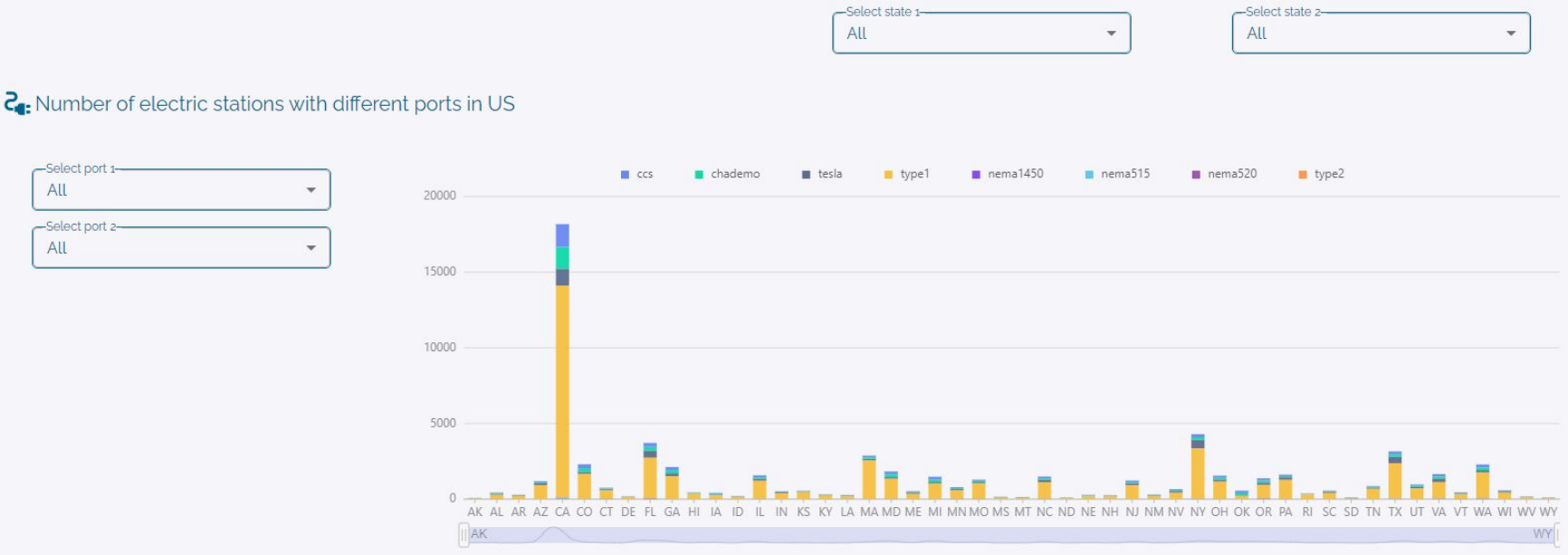
Preview


JuiceFinder
HOME
STATISTICS
FIND STATIONS
PLAN PATH
Locations
Starting Address
Levine Hall Philadelphia
Ending Address
MIT Cambridge
Max Distance
0.1 mile
0.5 mile
1 mile
Advanced
Match My Vehicle's Ports
Charging Level
DC fast charging
Station Port Type(s)
tesla
type2
Adapters at Hand
SHOW MY JUICE TRACK
Search
NEW YORK
MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
NEW JERSEY
Charging Station Details
The Plaza at Buckland Hills - Tesla Supercharger
Address: 1470 Pleasant Valley Road, Manchester, CT, 06042
Time/Constraints: 24 hours daily; for Tesla use only
Access: public
Network: Tesla
Number of Charging Ports:
16 DC fast charging ports
0 AC level1 charging ports
0 AC level2 charging ports
SEARCH NEARBY RESTAURANTS
© Mapbox © OpenStreetMap Improve this ma
Copyright © 2023 JuiceFinder
Contributors: (CL) (WL) (YS) (ZL)


JuiceFinder
Account Information
Email: moriartychuan@gmail.com
Saved Vehicle Information
Brand: Tesla
Type: car
Model: Roadster
Release Year: 2022
Vehicle Type: bev
Usable Battery Size: 200
Energy Consumption: 20.6
Port(s): tesla,type2
UPDATE SAVED VEHICLE


Nearby Restaurants
Filters
Distance
1 mile
5 miles
10 miles
Category Search
Sushi
Expected Visit Time
Day Saturday
Arrival Time - Leaving Time
Search Results
Sort by Rating
Sushi Ya 1.39 miles
8 reviews
1418 W Girard Ave, Philadelphia, PA, 19130
Kyushu Ramen & Sushi 0.88 miles
5 reviews
907 S 9th St, Philadelphia, PA, 19147
Midori Sushi 0.75 miles
18 reviews
516 S 5th St, Philadelphia, PA, 19147

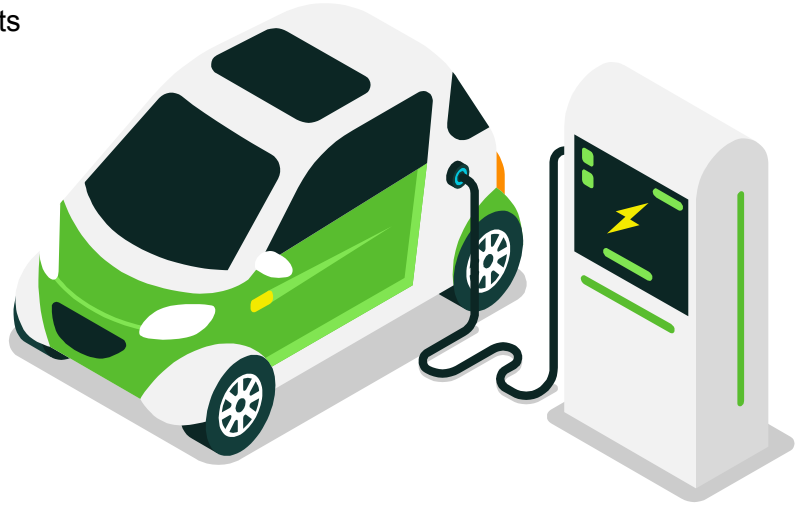
Preview


Select state 1
All
Select state 2
All
Number of electric stations with different ports in US
Select port 1
All
Select port 2
All
ccs
chademo
tesla
type1
nema1450
nema515
nema520
type2
20000
15000
10000
5000
0
AK AL AR AZ CA CO CT DE FL GA HI IA ID IL IN KS KY LA MA MD ME MI MN MO MS MT NC ND NE NH NJ NM NV NY OH OK OR PA RI SC SD TN TX UT VA VT WA WI WV WY
AK
WY

Datasets

Open-EV-dataset(JSON)

293 objects



Yelp Dataset(JSON)

150,346 rows

US **A**lternative **F**ueling **S**tations(csv)

70,034 rows

Data Preprocess and Normalization

Construct geometric point value using (longitude, latitude) coordinates

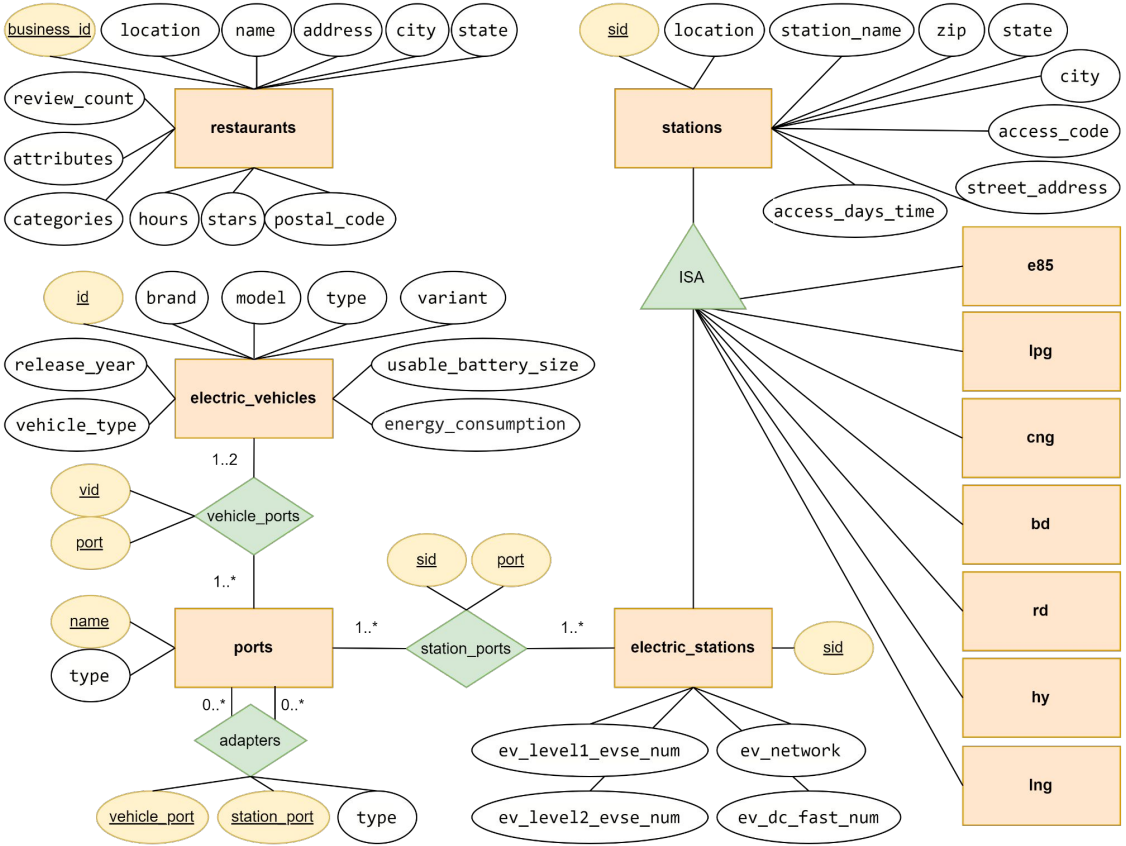
```
insert_data_sql = '''
INSERT INTO Restaurants (business_id, name, address, city, state, postal_code, location, stars, review_count, attributes, categories, hours)
VALUES (%s, %s, %s, %s, %s, %s, ST_SRID(ST_GeomFromText(%s), 4326), %s, %s, %s, %s, %s)
'''
```

Port name unification

AFS	OpenEV	Naming	Compatible with adapter(vehicle to station)
J1772	Type1	type1	tesla_to_type1, type2_to_type1
NA	Type2	type2	tesla_to_type2, type1_to_type2
NEMA515(level 1, slower)	--	nema515	type1_to_nema515,type2_to_nema515,tesla_to_nema515
NEMA520(level 1, slower)	--	nema520	type1_to_nema520,type2_to_nema520,tesla_to_nema520
NEMA1450(level2)	--	nema1450	type1_to_nema1450,type2_to_nema1450,tesla_to_nema1450
AFS	**OpenEV**	**Naming**	**Compatible with adapter(vehicle to station)**
J1772COMBO	ccs	ccs	tesla_to_ccs
CHADEMO	chademo	chademo	tesla_to_chademo
TESLA	tesla_suc	tesla	--
--	tesla_ccs	explode: tesla & ccs	

Every relation is in BCNF because each attribute depends on the primary key.

Schema Design and ER Diagram



Demo

Optimization

Built-In Distance Calculator

Use a MySQL generic function that calculate shortest distance between two geometries: point-point, point-polyline.

Polyline Simplification

Adapt Douglas-Peucker algorithm to reduce #waypoints by >95%.

Materialized View

Materialize frequently-used join results to accelerate lookups.

Spatial Index

The query optimizer checks the column's SRID attribute and uses appropriate calculations. E.g. R-tree.

Cache & Client-side Filter

Cache intermediate results in client to ensure a smoother user experience.

Optimization

Source	Destination	Distance(mile)	# Accurate Waypoints	# Simplified Waypoints	Time Cost on Google Map	Query Cost **before** Optimization	Query Cost **after** Optimization
Levine Hall	MIT	307	5195	13	>10s	>1min	**1.6s**
Levine Hall	Atlanta, GA	776	8481	19	>10s	>5min	**2.2s**

Complex Queries

```
SELECT DISTINCT
    sid,
    ST_Y(location) AS longitude,
    ST_X(location) AS latitude
FROM
    materialized_view_electric_stations_denorm E
WHERE
        ST_DISTANCE(
                location,
                ST_SRID(
                        ST_GEOMFROMTEXT('LINESTRING(
                            -75.15062 39.949657,
                            -75.142552 39.94646499999996,
                            ...
                            -75.15177599999998 39.901892000000004
                        '),
                        4326)
            ) < 804.67
  AND   sid IN (SELECT
                    sid
                FROM
                    station_ports
                WHERE
                    port IN ('tesla', 'type2'))
  AND   EXISTS(
                SELECT *
                FROM
                    electric_stations CLE
                WHERE
                     CLE.sid = E.sid
                  AND (CLE.ev_level2_evse_num > 0)
            );
```

Built-In Distance Calculator

Simplified Polyline

Find all stations that:

(1) Are close to some path;

(2) Contain some ports;

(3) Support some charging levels.

Complex Queries

```sql
WITH S AS (
    SELECT state FROM stations AS S
),
elec_stations AS (
    SELECT state, count(sid) AS num_stations, 'electric' AS stype FROM
    (   SELECT DISTINCT S.sid, state FROM electric_stations
        JOIN stations S on S.sid = electric_stations.sid     ) AS A
    GROUP BY state ORDER BY num_stations DESC
),
e85_stations AS (
    SELECT state, count(sid) AS num_stations, 'e85' AS stype FROM
    (   SELECT DISTINCT S.sid, state FROM e85
        JOIN stations S on S.sid = e85.sid     ) AS A
    GROUP BY state ORDER BY num_stations DESC
# ...
SELECT * FROM elec_stations
UNION
SELECT * FROM e85_stations
# ...
```

CTE

JOIN/GROUP BY

JOIN/GROUP BY

UNION

CTE, multiple aggregation and union over 9 entities.

```sql
WITH elecStations AS (
    SELECT sid, state FROM electric_stations
    NATURAL JOIN stations
),
elecStationsPort AS (
    SELECT * FROM elecStations
    NATURAL JOIN station_ports
),
aggTable AS (
    SELECT state, COUNT(DISTINCT(sid)) AS numStations, port AS portType
    FROM elecStationsPort
    GROUP BY state, portType
    HAVING state IN ('CA','MA') AND portType IN ('type1','$type2')
),
fullTable AS (
    SELECT * FROM
    (
        SELECT 'CA' AS state
        UNION SELECT 'MA' AS state ) AS stateList,
    (
        SELECT 'type1' AS portType
        UNION SELECT 'type2' AS portType ) AS portList
)
SELECT F.state, F.portType, IFNULL(numStations, 0 ) AS numStations
FROM fullTable AS F
LEFT JOIN aggTable AS A
ON A.state=F.state AND A.portType=F.portType
ORDER BY state ASC, portType ASC
```

NATURAL JOIN

NATURAL JOIN

GROUP BY

UNION

LEFT JOIN

CTE, filtering, aggregation, union, and multiple joins

Technical Challenges

Data Cleaning & Wrangling

1. Port naming unification
2. Explode column & Table splitting

Query Optimization

1. mySQL spatial indexing
2. Create indices

Geocoding & Route planning

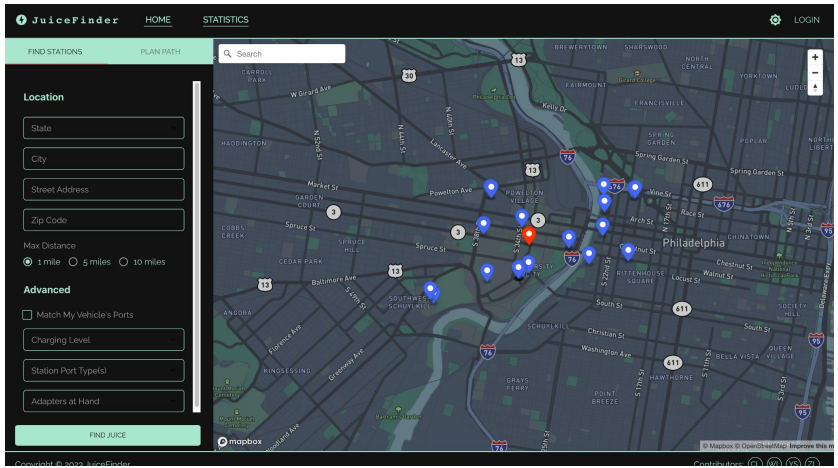
Use OpenRouteService API to plan a route of type GeoJSON

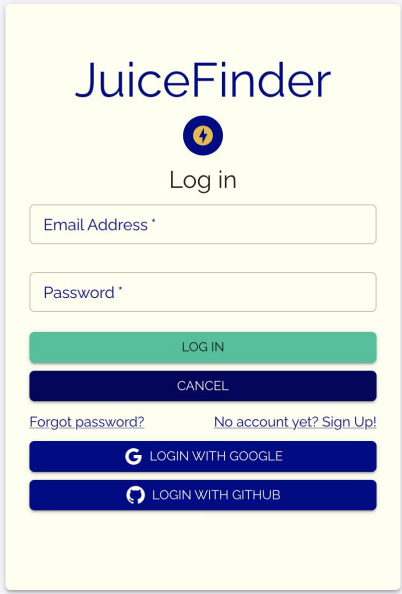
Login & User settings

1.Google, Github login API
2.Context & Current user state

Extra Credits Features

1. Log-in authentication with email/Google/GitHub
2. Light/dark theme switches
3. Extensive visualizations





Thank you!

Q&A